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ABSTRACT

THE RELATION OF AROUSAL TO RETENTION IN FREE LEARNING WAS STUDIED IN A 3 X 2 DESIGN EMPLOYING 48 UNDERGRADUATES AS SS, THREE LIST CONDITIONS (HIGH AROUSAL, LOW AROUSAL, MIXED LIST) AND TWO RETENTION INTERVALS (IMMEDIATE AND 3 DAYS). AROUSAL VALUE OF THE WORDS WAS BASED ON EARLIER STUDIES. CONTRARY TO PREVIOUS PAIRED-ASSOCIATE STUDIES, NO SIGNIFICANT INTERACTION BETWEEN AROUSAL CONDITION AND RETENTION INTERVAL WAS OBTAINED, NOR WAS REMINISCENCE DETECTED. HOWEVER, ALTHOUGH NO SIGNIFICANT DIFFERENCES WERE FOUND BETWEEN AROUSAL CONDITIONS ON IMMEDIATE RETENTION, SIGNIFICANTLY GREATER PERFORMANCE WAS ELICITED BY HIGH AROUSAL AT THE 3-DAY TEST. THE HIGH-AROUSAL MATERIAL DEMONSTRATED GREATER RESISTANCE TO FORGETTING THAN THE LOW-AROUSAL MATERIAL. A DIFFERENTIAL REHEARSAL INTERPRETATION OF THE DATA WAS SUGGESTED. (AUTHOR)

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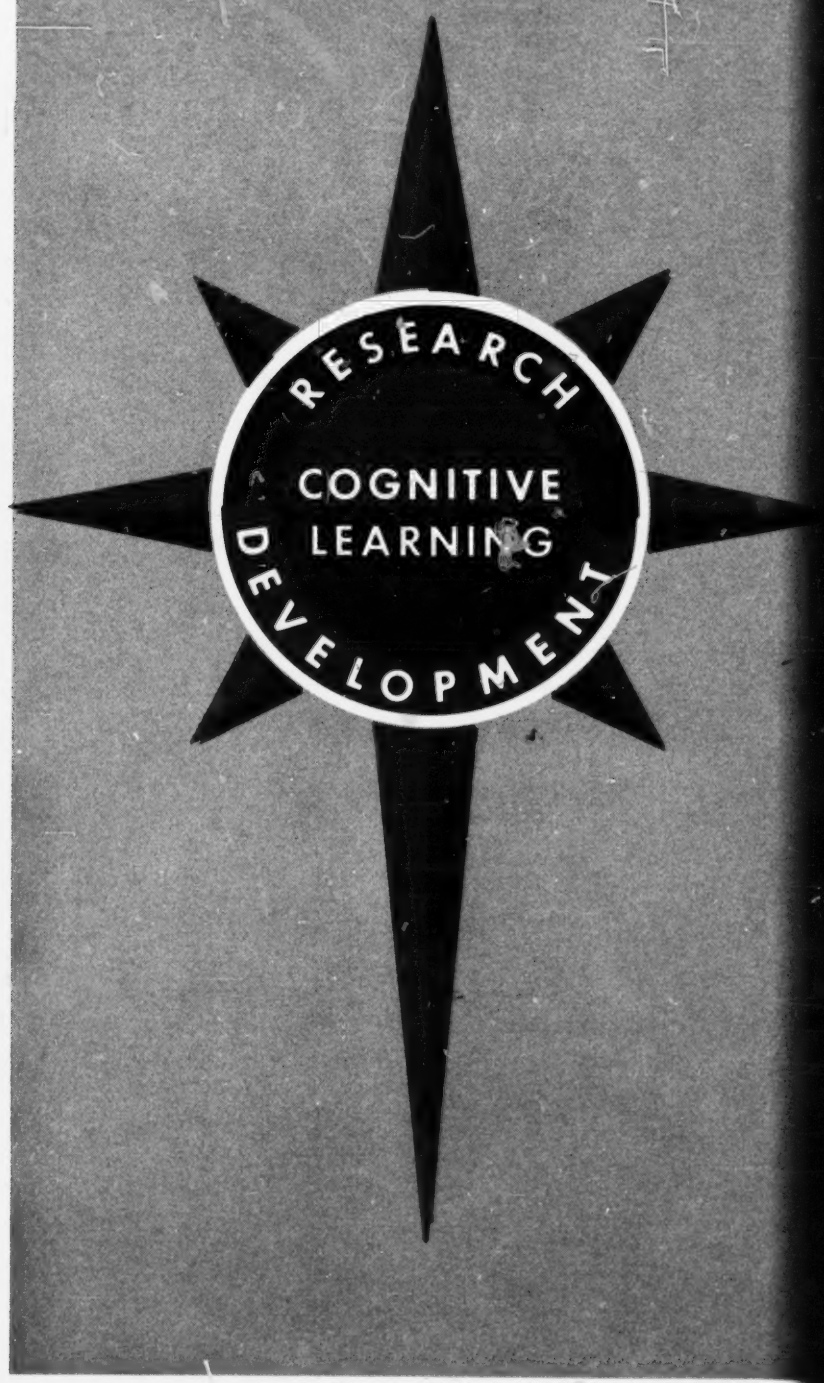

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MEMORY STORAGE IN FREE LEARNING AS A FUNCTION OF AROUSAL AND TIME WITH HOMOGENEOUS AND HETEROGENEOUS LISTS

By Frank H. Farley

Report from the Project on Motivation and Individual Differences in Learning and Retention
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Wisconsin Research and Development
Center for Cognitive Learning
The University of Wisconsin
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This Technical Report is from the Motivation and Individual Differences in Learning and Retention Project from Program 1. General objectives of the Program are to generate new knowledge about concept learning and cognitive skills, to synthesize existing knowledge, and to develop educational materials suggested by the prior activities. Contributing to these Program objectives, the Learning and Memory Project has the long-term goal of developing a theory of individual differences and motivation. The intermediate objective is to generate new knowledge of the learning and memory processes, particularly their developmental relationship to individual differences and to motivation.

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ABSTRACT

The relation of arousal to retention in free learning was studied in a 3 x 2 design employing 48 undergraduates as Ss, three list conditions (high arousal, low arousal, mixed list) and two retention intervals (immediate and 3 days). Arousal value of the words was based on earlier studies.

Contrary to previous paired-associate studies, no significant interaction between arousal condition and retention interval was obtained, nor was reminiscence detected. However, although no significant differences were found between arousal conditions on immediate retention, significantly greater performance was elicited by high arousal at the 3-day test. The high-arousal material demonstrated greater resistance to forgetting than the low-arousal material. A differential rehearsal interpretation of the data was suggested.

I

INTRODUCTION

In recent years very little research in verbal learning has been directed at motivational factors in retention. Typically, early research centered on repression or task-interruption paradigms. Recent theory on the relationship of arousal to memory consolidation (Walker & Tarte, 1963) has suggested that arousal may differentially affect short- and long-term retention. It is hypothesized that learning under high arousal produces a more actively consolidating trace that is relatively "unavailable" for immediate recall but is ultimately better consolidated for long-term recall than learning under low arousal. The trace formed under conditions of low arousal is more readily available for short-term recall but does not consolidate as well as traces supported by higher arousal levels and therefore shows poorer long-term retention. The prediction then is that high-arousal learning will show poor short-term retention but superior long-term retention relative to low-arousal learning, which will demonstrate superior short-term retention but poor long-term retention.

Kleinsmith and Kaplan (1963, 1964) have reported evidence supporting the predicted differential effect of arousal on short- and long-term memory. In the first study (Kleinsmith & Kaplan, 1963), words and numbers were used as stimuli and responses, respectively, in paired-associates (P-A) learning, with arousal defined in terms of Galvanic Skin Response (GSR) deflections to the words during learning. High- arousal words were then separated in the recall analysis from low-arousal words. Eight word-number pairs were presented once during the learning trial. The stimulus words alone were presented on the recall trial. Five recall intervals were used: immediate, 20 minutes, 45 minutes, 1 day, and 1 week. Responses learned under low arousal were recalled better at the immediate test, were undifferentiated at the 20-minute test from responses learned under high arousal, and showed "classical forgetting" at all the remaining rest intervals, whereas on the same tests the high-arousal material demonstrated reminiscence. Kleinsmith and Kaplan (1964) successfully replicated this finding using 0% association value nonsense syllables rather than words and three retention intervals—immediate, 20 minutes, and 1 week.

Walker and Tarte (1963) have also successfully replicated the Kleinsmith and Kaplan (1963) study in most respects. They employed three P-A lists each composed of 8 word-number pairs. One list was composed entirely of words classified a priori as high arousal (e.g., money, passion), a second list was likewise constructed of low-arousal words (e.g., walk, berry), and a third list contained 4 high- and 4 low-arousal words. In addition to the a priori classification, GSR was recorded during learning, and retention data were analyzed on the basis of GSR deflections as well as on the basis of the a priori classification.

The three studies cited above have all employed a P-A learning paradigm. Neither serial learning nor free learning has been used. One weakness of this strategy, which has been noted by Maltzman, Kanto, and Langdon (1966), is that in all cases it is difficult to separate the effects of arousal during learning from arousal during recall, as the high- or low-arousal stimulus term is presented to S both during learning and recall. The effects of arousal on retention may then be due to presence of the arousing stimulus during learning, during recall, or both.

The free recall paradigm presents no overt verbal stimulus during recall, and thus would eliminate the presence of the arousing stimulus. Serial learning, of course, would present the same stimuli during recall as were presented during learning.

The present study was undertaken with two related aims: first, to extend the analysis of arousal factors in short- and long-term retention

to the free learning paradigm employing the same words as Walker and Tarte (1963), and, second, to provide for the elimination of the overt arousing stimuli during recall, so as to determine whether the presentation of these stimuli only during learning is sufficient to influence recall scores. The possibility that the arousal effect may be enhanced or degraded by the context of the high- and low-arousing words additionally was studied by including a mixed list composed of half high- and half low-arousal words as used by Walker and Tarte (1963).

II
METHOD

SUBJECTS

Forty-eight university students with a mean age of 22.50 years were used as Ss.

PROCEDURE

Six groups were formed by random assignment from the 48 Ss, thus achieving eight Ss per cell in a 3 x 2 design. Three learning conditions (8 high-arousal words only, 8 low-arousal words only, and a mixed list of 4 high- and 4 low-arousal words) and two retention conditions, short-term retention (STR)—immediate recall, long-term retention (LTR)—recall 3 days later) were employed.

Each of the words was typed on a separate page in a booklet which contained eight pages for the words plus two filler pages inserted between each word. The inserted filler pages contained the numbers 0—10, inclusive, with the 0 typed on the center of the page, and the remaining numbers scattered randomly over the page. Each of these filler pages in a given booklet had the numbers scattered in a different random pattern. However the filler pages were the same between groups. The S's task was to connect the numbers by pencil beginning with 10 and working in order down to the 0 in the center of the page. The object of including two such pages inserted between the presentation of each word was to allow for the dissipation of arousal associated with a particular word before presentation of the next word. Walker and Tarte (1963) had used a similar procedure but required S to name colors rather than connect numbers as in the present case.

Each word was presented for 4 seconds, and each page of numbers was likewise presented for 4 seconds. The experimenter (E) signalled S to turn the page every 4 seconds. The words were presented in a different random order for each S except that within a given list condition, the order for the STR Ss was the same as the order for the LTR Ss. In the STR conditions, S was asked immediately following presentation of the eight words to write down all the words he could recall. Subjects were given 3 minutes for recall. In the LTR conditions, Ss were dismissed 3 minutes after completion of the presentation of the eight items. These Ss were told the experiment was completed, and were thanked for having taken part. Then, 3 days later, during a regular class lecture at approximately the same time of day as original learning, these LTR Ss were asked to recall as many of the words as they could and were given 3 minutes for this task.

III
RESULTS

Recall as a function of retention interval for the high-arousal, low-arousal, and mixed lists is presented in Figure 1. From Figure 1 it is clear that the three lists have almost identical percentage recall on the immediate retention test but are markedly different on the 3-day-interval test. Capacity to recall the low-arousal words dropped more rapidly over time than did capacity to recall the high-arousal words, with the mixed list falling in between. The high-arousal list demonstrated marked resistance to forgetting (24.4% drop in recall scores over 3 days) while the low-arousal list demonstrated massive forgetting (67.4% drop in recall scores over 3 days). No reminiscence was found with any of the lists, nor was an interaction between list type and retention interval obtained. Looking at the high- and low-arousal lists only, analysis of variance yielded a significant F of 14.86 (df = 1/24, $p < .005$) for retention interval and a significant F of 4.50 (df = 1/24, $p < .05$) for list effects. The interaction term was not significant.

Walker and Tarte (1963) performed an analysis combining the high-arousal items from the mixed list with the homogeneous high-arousal list, and similarly combining the low-arousal items from the mixed list with the homogeneous low-arousal list. Such a procedure is not entirely legitimate in that the items in the mixed list have been obtained under different conditions (item context) than the items in the homogeneous lists. A better procedure would be to analyze, within the mixed-list condition, the effects of word arousal and retention interval. Accordingly, recall of the high- and low-arousal words in the mixed list was separately analyzed, with percentage recall being presented in Figure 2.

From Figure 2 it is clear that the capacity to recall the low-arousal words dropped markedly as a function of time, whereas the capacity to recall the high-arousal words demonstrated considerably less diminution with time. With the high-arousal words the percentage drop in recall scores over 3 days was 15.4, while the comparable decline with the low-

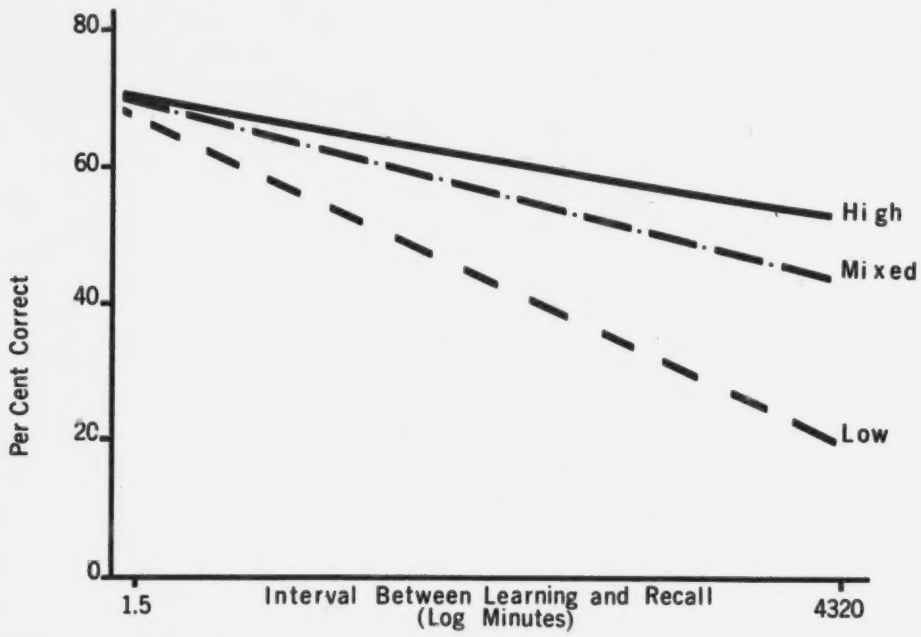

Figure 1. Immediate and long-term recall of the high-arousal, low-arousal, and mixed lists.

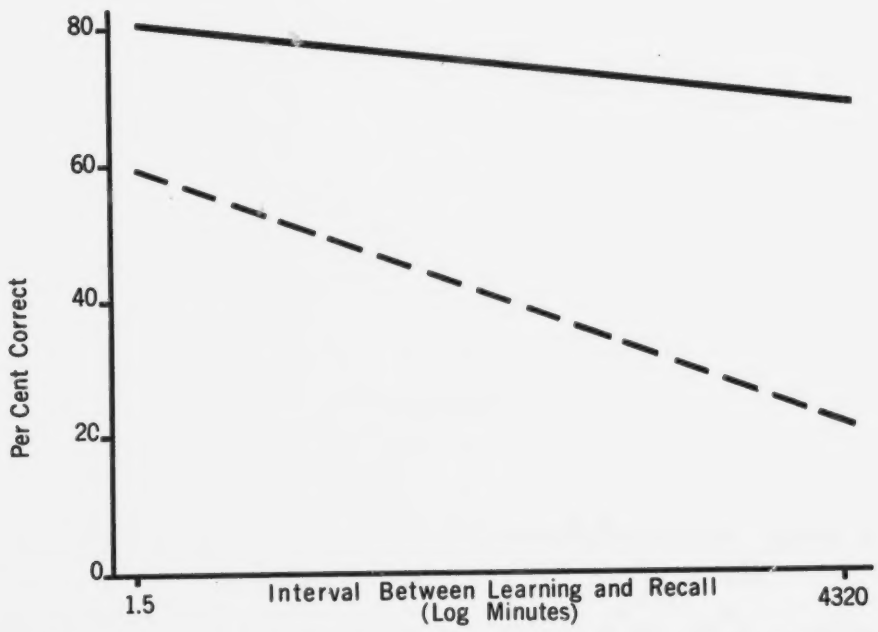

Figure 2. Immediate and long-term recall of the high- and low-arousal items in the mixed list.

arousal words was 63.1%. Analysis of variance of these data yielded a significant effect for arousal ($F = 21.46$, $df = 1/14$, $p < .005$) and an effect of retention interval that approached significance ($F = 4.02$, $df = 1/14$, $p < .10$). The interaction of arousal and retention interval was not significant ($F = 2.84$, $df = 1/14$). The lack of a significant temporal effect suggests that the overall loss from immediate- to long-term retention in the mixed list was lower than that of the combined high- and low-arousal lists, suggesting an effect of context on the retention function. However, one would not want to put much weight on such a suggestion as the mean percentage correctly recalled at the immediate-retention test for the combined high- and low-arousal lists was 68.8 and for the long-term retention test 37.5; whereas the comparable figures for the mixed list were 70.4% and 45.4%, respectively, indicating little difference attributable to "context." The unreliable effect of retention interval in the mixed list analysis may also be due to the small N involved.

IV
DISCUSSION

The major finding of the present study clearly is the lack of an interaction between arousal and retention interval of the type predicted by Walker and Tarte's (1963) formulations. No reminiscence was obtained, nor were low-arousal items in any analysis found to demonstrate superior recall to high-arousal items. In the homogeneous-list analysis high- and low-arousal words were effectively undifferentiated in immediate recall (recall of the low-arousal words was approximately 3% lower than that of the high-arousal words); whereas in the analysis of the heterogeneous list, immediate recall favored the high-arousal items by approximately 22%. The most general conclusion to be drawn is that long-term retention of the high-arousal material was superior to long-term retention of the low-arousal material; and that in the major analysis no meaningful difference in recall between high- and low-arousal words was obtained on the immediate retention test.

The results, though indicating no support for the crucial parts of the Walker and Tarte (1963) formulations, that is, where the predicted interaction is concerned, do resemble in certain respects the data reported by these authors. The marked resistance to forgetting of the high-arousal words relative to the low-arousal words is somewhat in line with their work, although it is even more similar to the findings of Maltzman, Kantor, and Langdon (1966) of better recall of high-arousal material at both immediate and delayed tests. This could be due to differential conscious rehearsal of these words, rather than differences in the intensity of perhaps "efficiency" of the consolidation process under high arousal. The latter interpretation, favored by Walker and Tarte (1963), would seem to require for support a significant interaction of arousal condition and retention interval of the type outlined by those authors. When such an interaction is not obtained, as in the present data, then a differential rehearsal interpretation is more tenable. It would be argued that the immediate-retention interval does not allow sufficient time for differential rehearsal to take place; thus, no difference is obtained at this interval between high- and low-arousal words.

The present data might lead one to argue that when the high-arousal and low-arousal stimuli are not overtly presented during test trials, the interaction of arousal and retention-interval is not obtained. Of course, other features besides the overt presence of the stimuli at recall differentiates free learning from P-A learning, and thus may share some of the responsibility for the present failure to obtain such an interaction. At any rate, it is concluded that in the free learning paradigm, high-arousal and low-arousal words are undifferentiated in immediate retention, but at a long-term retention measure, the high-arousal words are recalled significantly better than the low-arousal words. The high-arousal material demonstrates significantly greater resistance to forgetting than does the low-arousal material.

One problem in interpreting much of the present forgetting data, particularly those of the mixed-list analysis, has to do with whether differences in forgetting may be due to arousal or to differences in degree of original learning. As presented in Figure 2, the greater retention loss over 3 days with the low arousal, as compared to the high-arousal material, may be due to lesser rehearsal of the low-arousal items, differential consolidation between arousal conditions, or simply differences in degree of original learning. Controls over degree of original learning such as those recommended by Underwood (1964) would have to be exercised in future mixed-list studies. The homogeneous-list analyses present less difficulty of interpretation in the present case as retention scores for these two lists at the immediate test were almost identical, although, of course this does not represent a satisfactory equating of degree of original learning.

A further difficulty in studies of the present kind is in the definition of arousal in terms of the material being learned, rather than in terms of a set of operations distinct from that material. In other words, a more desirable paradigm is one in which arousal is manipulated, perhaps employing white noise, delayed auditory feedback, drugs, or instructions, independently of the material being learned. Thus greater control over the nature of the material can be exercised, so that possible characteristics differentiating between lists, other than their "arousal category," can be controlled. Additionally, it would be desirable to measure the effectiveness of one's arousal manipulations by simultaneous recording of a number of relevant psychophysiological indices, such as EEG and skin resistance.

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